

FIG. 1

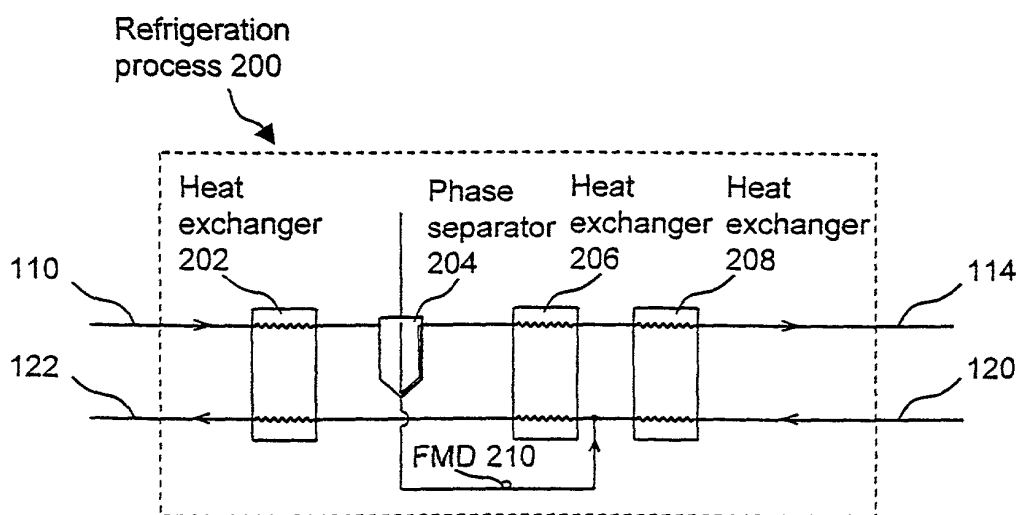


FIG. 2

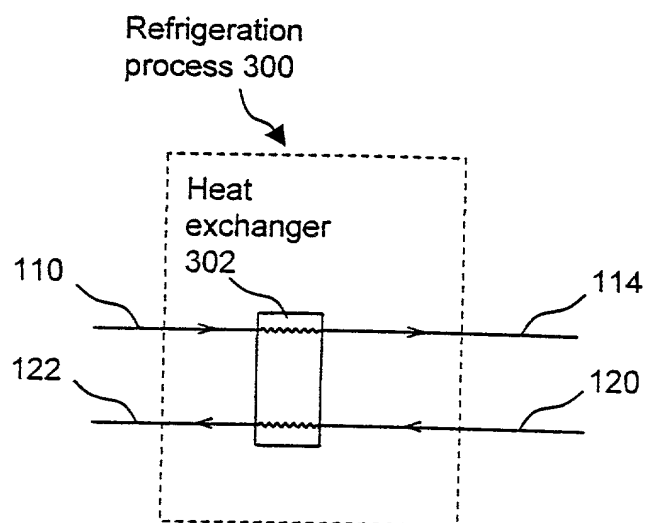


FIG. 3

Fig. 4

**Table 1.** Example blends for Polycold models. Percentage by mole for refrigerant mixture being circulated by compressor system.

	Molar composition (percent) of the overall refrigerant mixture used in representative models				
	Blend A	Blend B	Blend C	Blend D	Overall range (mole %)
Model number	PFC-1102 HC	PFC-662 HC	PFC-552 HC	PGC-152	
Minimum temperature achieved	-133 C	-150 C	-150 C	-133 C	
Refrigerant Component					
Argon	13	24	18	8	4 – 36
R-14	34	26	35	24	10 – 55
R-23	28	22	21	32	10 – 50
R-125	11	11	12	11	5 – 20
R-236fa	14	17	14	25	7 - 40

**Table 3:** MR formulation for minimal temperature down to 105 K

	Ingredient Name	Range (% by mole)
1	At least one of neon (Ne) or helium (He)	0.0 – 10.0
2	At least one of argon (Ar) or nitrogen (N <sub>2</sub> )	10.0 – 45.0
3	R-14 (CF <sub>4</sub> )	20.0 – 50.0
4	R-23 (CHF <sub>3</sub> )	10.0 – 30.0
5	R-125 (C <sub>2</sub> HF <sub>5</sub> )	8.0 – 15.0
6	R-134a	0.0 – 5.0
7	Other high boiling components: at least one of R-236fa, E-347, R-245fa, R-4112	0.0 – 3.0

Fig. 6

**Table 2.** Comparison of performance provided by two new blends without HCFC's compared with prior blends containing HCFC's.

Parameter	Blend containing HCFC's (replaced by Blend A) PFC-1100 HC		Blend A 1102 HC		Blend containing HCFC's (replaced by Blend D) PGC-150		Blend D PGC-150	
	Min. Load (150 W)	Max. Load (3600 W)	Min. Load (150 W)	Max. Load (3600 W)	No Flow	Max. Flow	No Flow	Max. Flow
Evaporator Inlet Temp. C	-134	-108	-135	-109	No data	-120	No data	-118
Evaporator Outlet Temp. C	-128	-97	-134	-91	No data	-108	No data	-106
Compressor Discharge Temp. C	105	124	102	114	100	110	102	110
Liquid Line Temp. C	24	27	25	25	25	28	22	27
Compressor Suction Temp. C	-4	7	13	14	10	14	16	23
Compressor Current, A	12.5	20	13	20	8.6	9.6	8.0	9.1
Voltage, V	460	460	460	460	230	230	230	230
Discharge Pressure, psig	161	350	205	365	180	240	185	255
Suction Pressure, psig	15	44	25	46	18	27	22	32
Gas Inlet Temp., C	NA	NA	NA	NA	25	25	25	25
Gas Flow Rate, SCFH	NA	NA	NA	NA	0	450	0	450
Gas Outlet Temp. C	NA	NA	NA	NA	NA	-115	NA	-115

Fig. 5

**Fig. 7**

**Table 4:** MR formulation for minimal temperature down to 118 K

	Ingredient Name	Range (% by mole)
1	At least one of argon (Ar) or nitrogen (N <sub>2</sub> )	10.0 – 40.0
2	R-14	20.0 – 50.0
3	R-23	10.0 – 40.0
4	R-125	0.0 – 35.0
5	R-134a	0.0 – 10.0
6	At least one of E-347, R-4112, R-236fa, R-245fa.	0.0 – 6.0

**Table 5:** MR formulation for minimal temperature above 130 K

	Ingredient Name	Range (% by mole)
1	At least one of argon (Ar) or nitrogen (N <sub>2</sub> )	2.0 – 40.0%
2	R-14	10.0 – 50.0%
3	R-23	10.0 – 40.0%
4	R-125	0.0 – 430.0%
5	R-134a	0.0 – 15.0%
6	At least one of R-245fa, R-236fa, or E-347, or R-4112.	0.0 – 10.0%

**FIG. 8**

**Table 6:** MR formulation for minimal temperature above 140 K

	Ingredient Name	Range (% by mole)
1	At least one of argon (Ar) or nitrogen (N <sub>2</sub> )	2.0 – 40.0%
2	R-14	10.0 – 50.0%
3	R-23	10.0 – 40.0%
4	R-125	0.0 – 30.0%
5	R-134a	0.0 – 15.0%
6	At least one of R-236fa, R-245fa, or E-347 or R-4112.	0.0 – 10.0%

**Fig. 9**

Fig. 10

**Table 7:** MR formulation for minimal temperature above 155 K

	Ingredient Name	Range (% by mole)
1	At least one of argon (Ar) or nitrogen (N <sub>2</sub> )	0.0 - 40.0%
2	R-14	5.0 - 50.0%
3	R-23	5.0 - 40.0%
4	R-125	0.0 - 40.0%
5	R-134a	0.0 - 30.0 %
6	At least one of R-236fa or R-245fa.	0.0 - 30.0%
7	E-347 or R-4112.	0.0 - 20.0%

**Table 8:** Freeze out Temperature for Selected Blends

Experimental Data of mixed refrigerant composition flowing through the evaporator

Note: ( $T_{MIN}$ ) is the minimal achieved temperature without freeze out.

No.	$T_{FR}$ , K ( $T_{MIN}$ ), K	Blend Composition: Mole %							
		Ar	R-14	R-23	R-125	R-134a	R-236fa	R-4112	Ne
1	(113) *	24.2	46.8	12.5	14.5				
2	(116-117)	41.0	32.0	18.0	9.0				
3	(115-16)	14.0	29.0	48.5					8.5
4	115-116	33.0	23.0	39.0					5.0
5	118-120	27.0	39.0	14.0	14.0		6.0		
15	116-117	25.0	27.0	17.0	R-218-18.0				13.0
6	115	15.0	22.0	37.0	24.2	0.0	1.8		
7	116-117	15.0	22.0	35.7	23.3	1.5	2.5		
8	120	17.3	20.0	33.0	21.5	3.7	5.3		
9	130	19.0	22.0	27.5	19.5	3.0	9.0		
10	125-127	15.2	19.3	31.5	21.0	3.5	9.5		
11	153	29.0	40.0			9.4	17.0	4.6	
12	155	32.3	47.0			5.6	11.7	3.4	
13	170	32.7	49.1				10.3	7.9	
14	135-137	24.0	25.0	23.0	---	12.5	15.5		

Fig. 11



**Table 9** Freezing temperatures for pure and mixed refrigerants with a residual oil

LT-32

Blend	Refrigerant	Composition (% by weight); Refrigerant% / Oil LT-32%	Freezing temp, K
1	Pure: R-23	94.9% / 5.1%	166.7
2	Pure: R-125	95.5% / 4.5%	169.6
3	Pure: R-218	96.3% / 3.7%	164.8
4	Pure: R-218	97.9% / 2.1%	150.3
5	MR: R-14/R-23/R-125	96.6% / 3.4%	167.4
6	MR: Ar/R-14/R-23/R- 125/R-236fa	99.0% / 1.0%	150.0

Fig. 12